In the Claims

Claims 1-31, 52, and 54-62 are pending in the application with claims 1 and 52 amended herein.

1. (currently amended) A method of forming a dielectric layer comprising:

providing a substrate comprising a silicon-containing surface;

forming a first metal-containing dielectric layer consisting of metal oxide over the surface, all the metal of the first dielectric layer consisting of at least one element selected from Group IVB of the periodic table; [[and]]

forming a second metal-containing dielectric layer consisting of metal oxide on and in contact with the first metal-containing dielectric layer, all the metal of the second dielectric layer consisting of at least one element selected from Group IIIB of the periodic table; and

including the first and second metal-containing dielectric layers in an integrated circuit device.

2. (previously presented) The method of Claim 1, wherein the metal of the first metal-containing dielectric layer consists of hafnium.

3. (previously presented) A method of forming a dielectric layer comprising:

providing a substrate comprising a silicon-containing surface;

forming a layer of silicon dioxide overlying at least one portion of the surface;

forming a metal layer over the layer of silicon dioxide;

heating the metal layer and layer of silicon dioxide to a temperature of from about 200°C to less than 400°C and combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide dielectric material comprised by a first metal-containing dielectric layer over the surface, all the metal of the first dielectric layer consisting of at least one element selected from Group IVB of the periodic table; and

forming a second metal-containing dielectric layer on and in contact with the first metal-containing dielectric layer, all the metal of the second dielectric layer consisting of at least one element selected from Group IIIB of the periodic table.

4. (previously presented) The method of Claim 3, wherein the metal layer comprises hafnium.

5. (original) The method of Claim 4, wherein the combining comprises providing conditions effective for the hafnium of the metal layer to chemically reduce the silicon dioxide layer.

6. (previously presented) The method of Claim 1, where the metal of the second metal-containing dielectric layer consists of one element selected from Group IIIB of the periodic table.

7. (previously presented) The method of Claim 1, where the metal of the second metal-containing dielectric layer consists of lanthanum.

8. (previously presented) The method of Claim 1, where the forming of the first metal-containing dielectric layer and the forming of second metal-containing dielectric layer comprise:

forming a hafnium-containing layer;

forming a lanthanum-containing layer over the hafnium-containing layer; and

exposing the hafnium-containing layer and the lanthanum-containing layer to an oxygen comprising atmosphere and heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer.

9. (original) The method of Claim 8, where forming the hafnium-containing layer and the lanthanum-containing layer comprises physical vapor deposition.

10. (previously presented) The method of Claim 8, where the exposing comprises ion bombardment of the first hafnium-containing layer and the lanthanum-containing layer using an ion bombardment energy of about 10 electron volts (eV) or less.

11. (original) The method of Claim 10 where the heating comprises heating to a temperature from about 200°C to about 400 C during the ion bombardment.

12. (original) The method of Claim 8, where the exposing comprises positioning the substrate within a reaction chamber and exposing the hafnium-containing layer and the lanthanum-containing layer to oxygen radicals within the reaction chamber.

13. (original) The method of Claim 8, where:

the forming the hafnium-containing dielectric layer comprises depositing hafnium to a thickness less than or equal to about 5 nanometer (nm); and

the forming the lanthanum-containing dielectric layer comprises depositing lanthanum to a thickness less than or equal to about 5 nm.

14. (original) The method of Claim 13 comprising a ratio of the hafnium thickness to the lanthanum thickness of from about 1 to 3 to about 1 to 4.

15. (original) The method of Claim 8, where;

the forming the hafnium-containing dielectric layer comprises forming a layer containing hafnium to a thickness of about 1 nm;

the forming the lanthanum-containing dielectric layer comprises forming a layer containing lanthanum to a thickness no greater than about 5 nm; and

wherein a ratio of thicknesses of the hafnium-containing layer to the lanthanum-containing layer is from about 1 to 3 to about 1 to 4.

16. (original) The method of Claim 1, where the forming of the first and second metal-containing dielectric layers comprises physical vapor deposition.

17. (original) The method of Claim 16, where physical vapor deposition comprises electron beam evaporation.

18. (original) The method of Claim 1, where forming the first metal-containing dielectric layer and the second metal-containing dielectric layer comprises forming the layers to have respective thicknesses having a ratio of from about 4:1 to about 1:4.

19. (original) The method of Claim 1, where the first metal-containing dielectric layer consists of hafnium oxide and the second metal-containing dielectric layer consists of lanthanum oxide.

20. (previously presented) A method for forming a MOS transistor, comprising:

providing a semiconductor substrate having a surface comprising silicon;

forming a hafnium-containing dielectric layer consisting of hafnium oxide on and in contact with the surface, such forming comprising initially forming a hafnium-containing metal layer;

forming a lanthanum-containing dielectric layer on and in contact with the hafnium-containing dielectric layer, such forming comprising initially forming a lanthanum-containing metal layer; and

forming a gate electrode over the hafnium-containing and lanthanum-containing dielectric layers.

21. (previously presented) The method of Claim 20, where the forming the hafnium-containing metal layer and the forming the lanthanum-containing metal layer both comprise physical vapor deposition.

22. (previously presented) The method of Claim 21, where physical vapor deposition comprises electron beam evaporation.

23. (original) The method of Claim 20, further comprising forming a layer of silicon dioxide over at least a portion of the surface comprising silicon, prior to the forming of the hafnium-containing dielectric layer.

24. (previously presented) The method of Claim 20, where the forming the hafnium-containing dielectric layer and the forming the lanthanum-containing dielectric layer further comprise exposing the hafnium- and lanthanum-containing metal layers to an oxygen comprising atmosphere while heating the metal layers to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer.

25. (original) The method of Claim 24, where forming the hafnium-containing dielectric layer and the lanthanum-containing dielectric layer comprise forming oxides of hafnium and lanthanum, respectively.

26. (previously presented) The method of Claim 24, where the heating comprises heating the hafnium- and lanthanum-containing metal layers to a temperature from about 200°C to about 400°C.

27. (previously presented) The method of Claim 25, where:

the hafnium-containing metal layer is formed over a layer of silicon dioxide; and

further comprising providing conditions effective for the hafnium-containing metal layer to chemically reduce the layer of silicon dioxide.

28. (previously presented) The method of Claim 25, further comprising:

providing ion bombardment of the hafnium-containing metal layer and the lanthanum-containing metal layer using an ion bombardment energy of about 10 eV or less and where the heating to an effective temperature comprises heating while providing ion bombardment to a temperature from about 200°C to about 400°C.

29. (previously presented) The method of Claim 25, where:

the forming of the hafnium-containing metal layer comprises forming such layer having a thickness no greater than about 5 nanometers;

the forming of the lanthanum-containing metal layer comprises forming such layer having a thickness no greater than about 5 nanometers; and

a ratio and a sum of the thicknesses of the hafnium-containing metal layer to the lanthanum-containing metal layer is from about 1 to 4 to about 4 to 1 and no greater than about 6 nm, respectively.

30. (previously presented) The method of Claim 29 where the thickness of the hafnium-containing metal layer is no greater than about 1 nm.

31. (previously presented) The method of Claim 29 where the hafnium-containing dielectric layer and the lanthanum-containing dielectric layer are collectively a gate dielectric layer, where the gate dielectric layer is formed having an equivalent oxide thickness less than or equal to 2 nm.

Claims 32-51 (cancelled).

52. (currently amended) A method of forming a dielectric layer comprising:

providing a substrate comprising a silicon-containing surface;

forming a first metal-containing dielectric layer over the surface, the first dielectric layer consisting essentially of hafnium oxide; [[and]]

forming a second metal-containing dielectric layer on and in contact with the first metal-containing dielectric layer, the second dielectric layer consisting essentially of lanthanum oxide; and

including the first and second metal-containing dielectric layers in an integrated circuit device.

Claim 53 (cancelled).

54. (previously presented) A method for forming a MOS transistor, comprising:

providing a semiconductor substrate having a surface comprising silicon;

forming a dielectric layer consisting of hafnium oxide overlying the surface;

forming a dielectric layer consisting of lanthanum oxide on and in contact with the hafnium oxide dielectric layer; and

forming a gate electrode over the hafnium oxide and lanthanum oxide dielectric layers.

55. (previously presented) A method for forming a MOS transistor, comprising:

providing a semiconductor substrate having a surface comprising silicon;

forming a layer consisting of hafnium on and in contact with the surface;

oxidizing the hafnium layer into a dielectric layer consisting of hafnium oxide;

forming a lanthanum-containing dielectric layer on and in contact with the hafnium oxide dielectric layer; and

forming a gate electrode over the hafnium oxide and lanthanum-containing dielectric layers.

56. (previously presented) A method of forming a dielectric layer comprising:

providing a substrate comprising a silicon-containing surface;

forming a layer of silicon dioxide overlying at least one portion of the surface;

forming a hafnium-containing layer over the layer of silicon dioxide;

combining hafnium of the hafnium-containing layer with oxygen of the silicon dioxide layer to form a hafnium oxide over the surface;

forming a lanthanum-containing layer over the hafnium-containing layer; and

exposing the hafnium-containing layer and the lanthanum-containing layer to an oxygen comprising atmosphere by ion bombardment using an energy of about 10 electron volts (eV) or less, and heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer.

57. (previously presented) The method of Claim 56 where the heating comprises heating to a temperature from about 200 C to about 400 C during the ion bombardment.

58. (previously presented) A method of forming a dielectric layer comprising:

providing a substrate comprising a silicon-containing surface;

forming a layer of silicon dioxide overlying at least one portion of the surface;

forming a hafnium-containing layer over the layer of silicon dioxide;

combining hafnium of the hafnium-containing layer with oxygen of the silicon dioxide layer to form a hafnium oxide over the surface;

forming a lanthanum-containing layer over the hafnium-containing layer; and

positioning the substrate within a reaction chamber and exposing the hafnium-containing layer and the lanthanum-containing layer to oxygen radicals within the reaction chamber and heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer.

59. (previously presented) A method for forming a MOS transistor, comprising:

providing a semiconductor substrate having a surface comprising silicon;

first forming a hafnium-containing layer and second forming a lanthanum-containing layer over the substrate, the first forming and the second forming encompassing physical vapor deposition;

exposing the hafnium and lanthanum containing layers to an oxygen comprising atmosphere by ion bombardment of the hafnium-containing layer and the lanthanum-containing layer using an energy of about 10 eV or less while heating the hafnium and lanthanum layers to a temperature from about 200 C to about 400 C to form oxides of hafnium and lanthanum as a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer, respectively; and

forming a gate electrode over the hafnium-containing and lanthanum-containing dielectric layers.

60. (previously presented) The method of claim 52 wherein the first dielectric layer consists of hafnium oxide.

61. (previously presented) The method of claim 52 wherein the second dielectric layer consists of lanthanum oxide.

62. (previously presented) The method of claim 3 wherein the second dielectric layer consists of metal oxide.